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## Growing pains beset miniature-display industry

**By David Lieberman**

SAN JOSE, Calif. -- The nascent market for miniature displays -- a.k.a. display chips -- is experiencing some growing pains. Entering the market with an approach whose most distinguishing characteristic is its lack of novel technology, startup S-Vision hopes to clear the hurdles to volume production that have bedeviled some developers of more exotic mini-display designs. One of those companies, Silicon Light Machines Inc. (Sunnyvale, Calif.), recently laid off about a third of its staff in a redirection of its effort to bring its Grating Light Valve technology to market.

Targeting the market for high-resolution projection displays, S-Vision (San Jose) is sampling preproduction SVGA (800- x 600-pixel resolution) screens on a build-to-order basis, with volume production scheduled to kick off in the fourth quarter. The initial recipients of the company's Micro LCDs are primarily projector companies, with a few monitor companies and PC companies in the mix.

Like many other manufacturers of mini displays, S-Vision relies on liquid-crystal-on-silicon (LCOS) technology. But its reflective-display technology is based on conventional twisted-nematic (TN) LC material and CMOS silicon.

By contrast, other mini-display makers -- such as Silicon Light Machines and Texas Instruments Inc. -- are using exotic materials or such novel technologies as micro-electromechanical systems (MEMS). S-Vision sees pitfalls to that approach.

"MEMS displays have a custom process, and the guys who are putting down PDLC [polymer-dispersed LC] have trouble with contrast ratio and need higher voltage; they can't use 3.3 or 5 V," said Ray Pinkham, strategic marketing manager at S-Vision.

Pinkham acknowledged that TN-on-CMOS "might not be the ultimate performance you can conceive of, but it takes the path that leverages off the momentum in the industry [behind] CMOS and TN LC, which virtually all the LCDs use. Other approaches will have to develop step by step; our approach leverages off what's already going on."

That's "a sensible approach, a low-risk approach, and it should be a relatively straightforward path to at least making something that will work," said Chuck McLaughlin of the McLaughlin Consulting Group (Menlo Park, Calif.). Labeling the S-Vision strategy "a long-overdue technological thrust," McLaughlin observed that "everybody's been trying all this really exotic stuff, but nobody has bet the farm on [TN LC and CMOS]. It may not result in the very best display -- maybe not be as fast as ferroelectric, for example -- but it's got to be very close."

Others disagree. David Mentley, director of industry research at Stanford Resources (San Jose, Calif.), said it's hard to discern what the "unique selling proposition" is for S-Vision's Micro LCD. Citing pending patents, the company declined to discuss the particulars of what it considers its unique selling proposition: an optical architecture that it claims will beat the competition in contrast and brightness while allowing less-expensive optical components to be used.

Nonetheless, some of S-Vision's competitors concede they have faced higher-than-expected hurdles to implementation. "Truthfully, things hadn't been going as fast as we'd hoped, say, a year ago," said Rob Corrigan, vice president of marketing at Silicon Light Machines (SLM), which burst onto the scene in September. "But we've now eliminated the issues we were bumping into, and the orientation for

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SLM's Grating Light Valve is a reflective MEMS display -- an approach whose manufacturability has yet to be proven. The Digital Micromirror Device, produced and marketed by Texas Instruments (Dallas), is also a reflective MEMS technology.

TI kicked off DMD production in April 1996 after having poured years and substantial sums into the technology's development. But the company has had a tough time ramping the product to volume.

"We're not happy where we are with DMD cost and overall manufacturing yields at this point," acknowledged Sherel Horsley, senior vice president of marketing for TI's Digital Imaging Group, speaking at a mini-display roundtable in May.

Corrigan of SLM, on the other hand, said that his company's reflective-MEMS effort is "rockin' and rollin'" and that "things are going quite well." But the company did make some adjustments recently after taking stock of the effort, he acknowledged. "A few months ago, we recognized that there was a more straightforward architecture that in some respects represented a shorter path to market for us, and it meant we needed fewer people developing custom silicon-processing technology."

SLM, unlike some other startup display makers, has been doing its own silicon processing, primarily at Stanford University's Center for Integrated Systems. "We'd intended all along to leverage the existing silicon infrastructure," Corrigan said. "But we found that to maintain process controls and really refine repeatability and precision into the runs, we would have had to more or less set up a dedicated silicon processing system," even though the technology uses "standard [semiconductor-manufacturing] equipment and materials."

Corrigan said the redesign removes the need to "own and operate dedicated equipment by changing pixel design and process flow to simplify things. The flow is now entirely CMOS-compatible wafer processing up to a few steps at the end, for which we're building a small clean room here. So we put an RFQ out on the street to a few local foundries in the Bay Area and got several responsive bids. We've picked one and are now doing most of our silicon processing there."

"As a result, there's now a very limited amount of processing we have to staff."

The upshot has been a layoff at the small startup. "It wasn't fun going down from 31 [employees] to 20, but it was the right thing to do," Corrigan said. "But we're still hiring in other areas. We're still looking for people on the systems side -- electronics and optics."

"The transition went as smoothly as one could hope. It's just one of those adjustments you make, but it doesn't represent anything more than that."

Unconfirmed reports have surfaced that SLM has given up on making an X-Y matrix of MEMS for a direct-view display and that it will now focus on making only a linear array. One source, who asked not to be named, said the company's current plan "is to make a projection device that consists of laser-light sources and a horizontal or vertical GLV array that's mechanically scanned in the other direction. That's probably more dependent on finding cost-effective laser-light sources than it is on the array."

Corrigan would say only that SLM has "never announced specific product intentions, so it's hard to comment on changes in products we haven't announced. But we've got parts running in the labs, and the yields look astounding. Confidence right now is at an all-time high."

Projection-display systems -- not head-mounted displays -- may be the most appropriate target for the emerging mini displays. "The only people using this [miniature] display stuff for HMDs have all gone belly up -- Forte and Virtual I/O," said Roger Stewart, director of the solid-state-display laboratory at Sarnoff Corp. (Princeton, N.J.).

The electronic-projector market, by contrast, is thriving. And the next big thing in projectors, according to Gil Miller, product marketing manager at projector-market leader In Focus Systems, Inc. (Wilsonville, Ore.), is likely to be a reflective display technology like S-Vision's. "I don't know which [technology] it will be," he said, "but it probably won't be TI's DMDs, given the yield problems."

"Projection is a big market [for miniature displays], proven by TI's DMDs and the 1.3-inch polysilicon LCDs," said Bruce McWilliams, S-Vision's president and chief executive officer. "And that market is very much looking for a good solution for things like SXGA [1,280- x 1,024-pixel] and HDTV [above 1,000-line] formats. Maybe

our story isn't the sexiest technical thing, but it seems like the obvious approach for chip-based displays."

Indeed, the company has gone as far as to put together a beta projector using its displays, and it claims the approach has already snagged a customer. Sales manager Al Davis said S-Vision signed an agreement in May "with a major distributor of projection systems to deliver an XGA [1,024- x 768-pixel-resolution], 1,000-lumen projector."

Preproduction OEM projectors will sample early in the fourth quarter. S-Vision expects its distribution partner to be shipping projectors to end users before the year is out.

The Micro LCDs are now being run on 6-inch wafers at two unnamed foundries, yielding a maximum 50 displays per wafer. A move to 8-inch wafers is in the works that would boost the potential yield to 80 displays.

S-Vision has a small back-end LCD operation running in Twinsburg, Ohio, and has begun building a larger facility there.



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